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NUMBER THEORY AND DIOPHANTINE ANALYSIS.

145. Proposed by J. D. WILLIAMS, being the 12th of his fourteen challenge problems proposed in 1832.

Make $x^2 + y^2 = \square$, $\frac{5}{4}(x^2 + y^2) = \text{a cube}$, $xy = 2x^3$, $2(x+y) + \frac{xy}{x+y} = \square$, and $(x^4 + y^4)(x^2 + y^2) - (x^5 + y^5) \sqrt{x^2 + y^2} = \square$.

No solution has been received.

146. Proposed by PROFESSOR JOSE J. CORONADO, Halapa, Veracruz, Mexico.

Find two numbers whose difference is equal to the difference of their cubes.

I. Solution by G. B. M. ZERR, Philadelphia, Pa.; A. H. HOLMES, Brunswick, Me.; and J. E. SANDERS, Reinersville, O.

Let x, y be the numbers. Then $x - y = x^3 - y^3$, $1 = x^2 + xy + y^2$, if $x \neq y$. Let $x = vy$.

$$\therefore y = \frac{1}{\sqrt{(v^2 + v + 1)}}, \quad x = \frac{v}{\sqrt{(v^2 + v + 1)}}.$$

Let $v^2 + v + 1 = (nv + 1)^2$.

$$\therefore v = \frac{1 - 2n}{n^2 - 1}, \quad \therefore x = \frac{1 - 2n}{n^2 - n + 1}, \quad \text{and} \quad y = \frac{n^2 - 1}{n^2 - n + 1},$$

where n can have any value, positive or negative, whole or fractional.

II. Solution by DR. L. E. DICKSON, The University of Chicago.

$x - y = x^3 - y^3$. Say $x \neq y$. $\therefore 1 = x^2 + xy + y^2$.

If any two numbers are desired, there are an infinitude of answers. If two integers are desired (neither zero), then one must be negative, otherwise $x^2 + xy + y^2 \geq 3$. Say y is negative, $= -z$. $\therefore 1 = x^2 - xz + z^2$, x and z positive integers; $\therefore 1 - xz = (x - z)^2$; $\therefore 1 - xz = 0$, or positive.

$xz \geq 1$. $\therefore x = z = 1$. If one is zero, the other $= 0$ or ± 1 .

\therefore Only integral sets are $(0, 0)$, $(0, \pm 1)$, $(\pm 1, 0)$, $(\pm 1, \mp 1)$.

Combined: (x, y) , $\begin{matrix} x=0, & \pm 1, \\ y=0, & \pm 1. \end{matrix}$

MISCELLANEOUS.

170. Proposed by J. W. NICHOLSON, A. M., LL. D., Baton Rouge, La.

If n and m are any two real numbers whatever, n being less than m , find a rational r such that $\sqrt[n]{n} < r < \sqrt[m]{m}$.

Solution by G. B. M. ZERR, A. M., Ph. D., 4243 Girard Avenue, Philadelphia, Pa.

This depends on how we choose our markings. If we choose the natural numbers 1, 2, 3, 4, etc., $\sqrt[n]{n}$ may be defined by two infinite series of rational numbers, and $\sqrt[m]{m}$ may also be so defined. As these two infinite